Mortality Among U.S. Gulf War Veterans Who Were Potentially Exposed to Nerve Gas at Khamisiyah, Iraq

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Abstract
In March 199, U.S. troops destroyed an Iraqi ammunition storage complex at Khamisiyah, Iraq. The Khamisiyah complex consists of nearly 200 storage bunkers and buildings and it covers a 25 km2 area.

Subject Terms

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I. Introduction

In March 1991, U.S. troops destroyed an Iraqi ammunition storage complex at Khamisiyah, Iraq. The Khamisiyah complex consists of nearly 200 storage bunkers and buildings and it covers a 25 km^2 area. Those performing the demolition were unaware of the presence of ammunitions containing the nerve agents, sarin and cyclosarin. At the time of the demolition there were no medical reports by the U.S. Army Medical Corps that were consistent with signs and symptoms of acute sarin gas exposure.[1] Also, there were no confirmed detections of chemical agents by monitoring equipment.

While inspecting the demolition site 8 months later, representatives from the United Nations Special Commission (UNSCOM) found artillery shells and rockets containing nerve agents. In response to the UN findings and the mounting concerns for the health of US military personnel who were in the area of Khamisiyah at the time of the weapons demolitions, the Department of Defense (DoD) conducted exposure modeling to determine the extent of exposure to nerve agents among U.S. military personnel. The result of this modeling effort was the identification of troops assigned to the units situated under the projected path of the nerve agent plume. The first model was developed in 1997, and is known as the 1997 exposure model. Improving upon the 1997 model, DoD developed a newer model in 2000, known as the 2000 model. According to both DoD Models, a large number of U.S. troops, approximately 100,000, may have been exposed to extremely low level of nerve agents as a result of the Khamisiyah demolition incidence on March 10, 1991.

This current report compares the overall and cause-specific mortality experience of Gulf War veterans who were potentially exposed to the nerve agents based on the DoD 1997 model and the 2000 model with that of Gulf War veteran controls who also served in the Gulf but were not considered exposed. Also addressed is the mortality risk of veterans who were exposed only within the context of the 1997 exposure model relative to other subgroups of potentially exposed veterans.

II. Materials and Methods

1. Study Subjects

On February 27, 2002, the Department Of Defense (DoD) provided the Department of Veterans Affairs (VA) with a roster of Gulf War veterans who were considered exposed to the nerve agents based on the 1997 model and/or the 2000 model. (Figure 1)

a. 1997 Model:

A total of 98,608 unique individuals were identified as potentially exposed based on the 1997 exposure model (Figure 2). These consisted of a group of 32,627 veterans coded as "D"eleted (i.e., considered exposed only using the 1997 model) and a second group of 65,981 veterans coded as "O"ld, (i.e., considered exposed based on both the 1997 and the 2000 model). Using the Department of Veterans Affairs and the Social Security Administration (SSA) sources of vital status ascertainment, 1,404 deaths were identified through December 31, 2001. Of these, 69 were excluded from the analysis because they died either prior to the start of Operation Desert Shield (n=24) or prior to the date of the Khamisiyah demolitions (n=45). The final number of veterans included in the analysis of those exposed based on the 1997 model was 98,539, including 1335 deaths occurring through December 31, 2001. Overall mortality analysis was conducted for all 1,335, while cause-specific mortality analysis was limited to those 961 deaths with known causes occurring through December 31, 1999.

b. 2000 Model:

A total of 101,752 unique individuals were identified as being potentially exposed based on the 2000 exposure model (Figure 3). This group of exposed veterans consisted of 35,771 veterans coded as "N"ew (i.e., only identified as exposed in the 2000 model) and the same 65,981 veterans coded as "O"ld (i.e., who were exposed based on both the 1997 and 2000 exposure models). Again using two sources for vital status determination, 1398 deaths through 2001 were identified. Of these, 22 were deleted from the study because their dates of death preceded either the beginning of Operation Desert Shield (n=21) or the

Khamisiyah demolitions (n=1). Overall mortality analysis was done on the remaining 1, 376 deaths occurring through December 2001, while cause-specific mortality analysis was limited to the 986 deaths with known causes through December 31, 1999.

c. Non-exposed Gulf War veteran controls:

Gulf veteran controls were selected from a pre-existing database of almost 260,000 Army Gulf veterans (Figure 4). This file was matched against both 1997 and 2000 exposure roster to identify veterans who were not considered exposed based on either model. This resulted in a file of 225, 059 unexposed controls. As was done with both exposed group, controls were also matched against vital status databases. Using these sources, 2977 deaths were identified through December 31, 2001, of which 39 were ineligible. The remaining 2938 deaths were used for overall mortality analysis. Those 2189 deaths with known causes occurring through December 31, 1999, were used in cause-specific mortality analysis.

2. Vital Status determination and collection of cause of death data

Vital status follow-up for each Gulf War veteran began on March 10, 1991, and ended on the date of death or December 31, 2001, whichever came first. March 10, 1991 was chosen as the beginning of follow-up as this was the relevant day of weapon demolition at Khamisiyah. December 31, 2001 was used as the end of follow-up as sources used for vital status ascertainment were incomplete after that date. Vital status was determined using databases of the Department of Veterans Affairs (VA); and the Social Security Administration (SSA). A recent study indicates that the VA Beneficiary Identification and Record Locator Subsystem (BIRLS) and the SSA, Master Beneficiary Record (MBR) collectively captured 89% (95% confidence interval, 83-97%) of all Gulf War era veteran deaths.[2]

Causes of death were obtained from the National Center for Health Statistics which maintains the National Death Index database. Since 1979, state vital statistics offices have reported all deaths, including data on cause of death, to the NCHS. At the time of matching NDI had cause of death data through December 31, 1999. Cause of death data for deaths occurring in 2000 should be available by

the end of April 2002; and for 2001 deaths, a year later by April 2003. Causes of death were coded by a qualified nosologist using the International Classification of Disease 9th revision for deaths through 1998 and 10th revision for 1999 deaths.[3,4] For statistical analysis, causes of death coded by the 10th revision were converted to the corresponding 9th revision codes. The veteran's deployment or exposure status was not known to the coders.

3. Statistical Analysis

The data were analyzed in three stages. First, the number of person-years at risk of dying was counted from March 10, 1991, to December 31, 2001, or the date of death, whichever came first. The relative frequencies of overall deaths through 2001 and cause-specific deaths through 1999 were compared between exposed Gulf veterans and unexposed Gulf veterans on the basis of person-years at risk. Unadjusted rate ratios were calculated from the crude death rates.

Second, Cox proportional hazards models were used to account for possible confounding and effect modification by selected covariates related to a veteran's risk of dying from a specific cause according to time since the veteran's entry into the cohort.[5] Adjusted rate ratios (RR) for overall and cause-specific mortality derived from these models were used to approximate relative risk. The covariates considered in the models included exposure status (yes/no), age at entry into follow-up, race, gender, and type of military unit.

Third, the cause-specific mortality through December 31, 1999, of both exposed and unexposed Gulf War veterans was compared separately with the number of deaths expected in the overall U.S. population, with adjustment for age, gender, race, and year of death. The results are presented as standardized mortality ratios (SMR) expressing the ratio of the observed number deaths among veterans to the expected number of deaths in the general population.[6] Any SMR when its 95 percent confidence interval did not include 1.0 was considered statistically significant.

III. Results

1. Characteristics of the veteran groups (Tables 1 and 2)

Table 1 compares all three groups of Gulf veterans for selected demographic and military service characteristics. Two exposed groups and the control group are similar to each other with respect to race, gender and age: white 62.2% to 63.1%; male, 89.4% to 91.6%; and born prior to 1968, 66.6% to 69.2%. The three groups were also similar regarding military service characteristics, with 98% to 100% being in the Army and 88.3% to 89.3% being enlisted. The only difference was in the unit composition of the groups. While 83.4% of those exposed based on the 1997 model served in active duty units, only 74.2% and 75.3, respectively of those exposed based on the 2000 model and controls served in active duty units.

Table 2 compares potentially exposed veterans to each other when grouped together based on their "O"ld, "N"ew, or "D"eleted designation. All three groups were similar regarding race, with between 62.2% and 64.5% being white. However, those coded as "N"ew had more females (12.5%) than either those coded as "O"ld (9.5%) and those coded as "N"ew (6.2%). The only other discernible difference between the three groups is that 91.5% of the "D"eleted group served in an active duty unit, compared to only 79.4% of the "O"ld and 64.7% of the "N"ew.

2. Overall mortality (Tables 3,4 and Figure 5)

Table 3 shows overall morality risk associated with exposure based on both the 1997 and 2000 exposure models. Mortality risks for veterans with the "O"ld, "N"ew and "D"elete designations are also presented. Unexposed control veterans have an overall mortality rate of 12.15 deaths per 10,000 person-years at risk. Exposed veterans whether grouped together based on exposure model year or "O"ld, "N"ew or "D"elete designation have similar overall mortality rates: 12.61 for 1997 model year veterans, 12.59 for 2000 model year veterans, 12.80 for "D"eleted veterans, 12.73 for "N"ew veterans, and 12.52 for "O"ld veterans. After adjusting for differences in demographic and military characteristics, those veterans considered potentially exposed based on the 1997 model have a borderline statistically significant increased risk of mortality compared to unexposed veterans, (RR, 1.06; 95% C.I. 1.00-1.14). It appears that this risk is primarily due to the overall mortality

of those considered exposed based only on the 1997 exposure model, i.e. coded as "D"eleted, (RR, 1.12; 95% C.I. 1.02-1.24). This small but statistically significant increased risk of mortality may mean that there were about 25 additional deaths in the Deleted group than what one would have expected from the Gulf War veteran controls.

Overall mortality risk estimates associated with each of the covariates used in the Cox models are presented separately for the 1997 and 2000 exposure models (Table 4). As expected as age increased so did the risk of overall mortality in both the 1997 and 2000 exposure models, (RR, 1.04; 95% C.I., 1.04-1.05, and RR ,1.04; 95% C.I., 1.03-1.05, respectively). Also as expected males compared to females had statistically significant increased risk of overall mortality in both the 1997 and 2000 models (RR, 1.71; 95% C.I., 1.50-1.95, and RR, 1.73; 95% C.I., 1.52-1.96, respectively). Another expected finding was that whites compared to non-whites had a statistically significant decreased risk in mortality in both the 1997 (RR, 0.91; 95% C.I., 0.86-0.97) and 2000 model (RR, 0.91; 95%, C.I. 0.,85-0.96). Finally, in both the 1997 and 2000 models, those who served in a National Guard or Reserve unit had statistically significant increased risk in overall mortality compared to those who served in active duty units, (RR, 1.19; 95% C.I., 1.11-1.28 and RR, 1.19; 95% C.I., 1.12-1.28,respectively).

3. Cause-specific mortality (Tables 5 and 6)

Table 5 presents cause-specific mortality rates through 1999 for the various groupings of exposed veterans and for all unexposed veterans. Death rates per 10,000 person-years for all disease related deaths were similar among control group and the various grouping of exposed veterans. All 6 groups of veterans also had similar rates of deaths for the other causes presented in Table 5.

Table 6 presents a further analysis for two categories of cause-specific mortality appeared to be elevated among Gulf veterans who were only in the 2000 Model and one category among Gulf veterans who were only in the 1997 Model. Using the Gulf veterans who were not considered as "exposed" as a referent group, and after adjustment for differences in age, gender, race and unit

component between the two groups, all three adjusted mortality rate ratios were not statistically significant.

4. Comparison with general population (Tables 7, 8 and Figure 6)

As compared with the general population of the United States, all six Gulf veteran groups had significantly lower overall and cause-specific standardized mortality ratios (SMR's). Deaths among all 6 groups of veterans occurred at a rate no more than half that expected in the U.S. population after adjustment for age, sex, race and year of death. Almost all of eight broad category of cause of death listed in the tables (Table 7 and 8) were significantly lower among Gulf war veterans except for motor vehicle accident and suicide.

IV. Review of the VBA Report[7]

During the last week of February, 2002, VBA provided a file of 1,337 deceased Gulf War veterans and a file of 134,463 veterans who were included in its February 22nd report. Table 9 lists veterans included in the DOD file and VBA file and the number of deaths in each exposure group. It is very apparent that although the number of veterans in each exposure group classified by VBA and DOD is approximately the same, the number of deaths identified in each group was substantially different. To understand a reason for the discrepancy we first compared the identity of individuals on the DOD file to those on the VBA file.

The DOD file has 1,056 veterans who were not in the VBA file, while the VBA file had 1,140 veterans who were not in the DOD file. Among the 1,140 veterans only in the VBA file, 9 deaths were found. Among the 1,056 veterans only in the DOD file, 368 deaths were reported (Figure 7). Of the 9 deaths only in the VBA file, all 9 were classified as "Deleted". Of the 368 deaths only in the DOD file, 4 were coded as "Deleted", 363 as "New" and 1 as "Old".

We compared the exposure status of 133,323 veterans who were in both the VBA and DOD file, which is 99.2% of the total veterans in the VBA file (Table 10). As the table shows, classification of veterans for their exposure status was in agreement between VBA and DOD for 132,580 of 133,323 (or 94.5%) veterans. Of the remaining 743 veterans, 661 were coded as "Deleted" by VBA and as "Old" by DOD, while 82

were coded as "Old" by VBA and as "New" by DOD. Of the 661 veterans who were coded as "Deleted" by VBA, 650 were not alive as of December 31, 2001, of which all but 4 died prior to year 2000.

To further evaluate the VBA classification of exposure status of deceased veterans, we list all 1,337 deceased veterans by year of death and by VBA exposure group (Table 11 and Figure 8). Among the two groups, "New" and "Old", which constitute 2000 DOD Model, very few deaths occurred in each year during a period from ≤1991 to 1999; while in "Deleted" group, the number of deaths that occurred through 1999 were approximately the same. The annual mortality rate for year 2000 and 2001 were approximately the same among three groups.

Data from Tables 9-11 suggest very strongly that VBA classified a vast majority of veterans who were exposed based on the DOD 2000 Model but died prior to year 2000 into the "Deleted" group. This resulted in artificial inflation of the mortality rate for each year through year 1999 for "Deleted" group. This could have happened if VBA was tabulating data from the DOD 2000 letter notification file. It is our understanding that DOD attempted to delete veterans from the 2000 notification file if they were known to have died at the time of mailing in order not to upset surviving family members..

V. Summary

1. The data from this study do not support the existence of a large excess of overall mortality among any group of potentially exposed Gulf War veterans.
2. The cause-specific mortality rates for 6 categories of deaths were similar among the potentially exposed groups.
3. As compared with the U.S. general population, all potentially exposed groups had substantially lower overall and cause-specific standardized mortality ratios. Deaths among these veterans occurred at a rate no more than half that expected in the U.S. population after adjustment for age, sex, race, and year of death.
4. A review of the VBA data strongly suggest that the misclassification of veterans who were in the DOD 2000 Model but died prior to year 2000 into "Deleted" group may explain the 10-fold excess death rate among this group.

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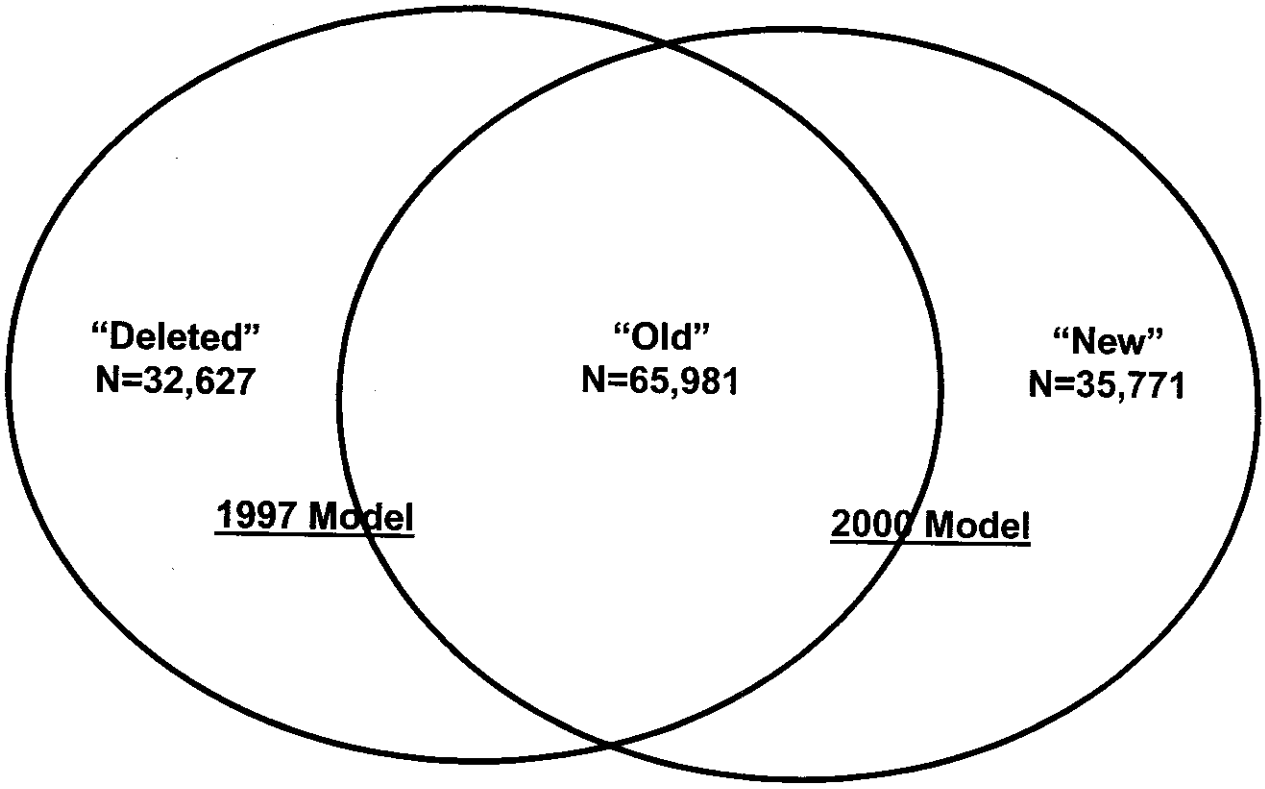

1997 DOD Model: Deleted + Old = 98,608
2000 DOD Model: Old + New = 101,752

Source: DOD/Deployment Health Support, 2/27/02

Figure 1: Gulf War veterans who were potentially exposed to nerve gas at Khamisiyah, Iraq

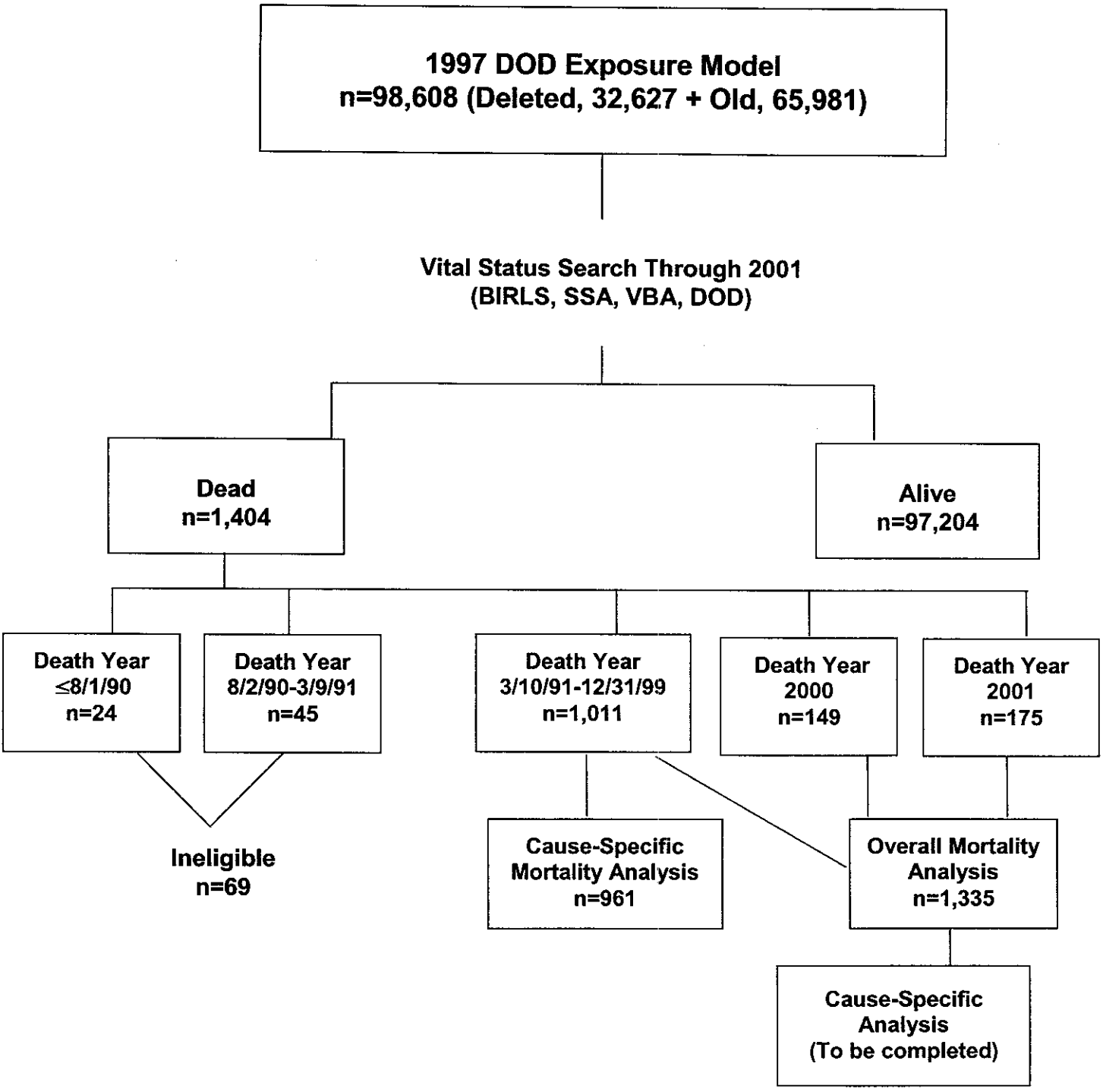

Figure 2: Selection process of eligible veterans for the 1997 DOD exposure model

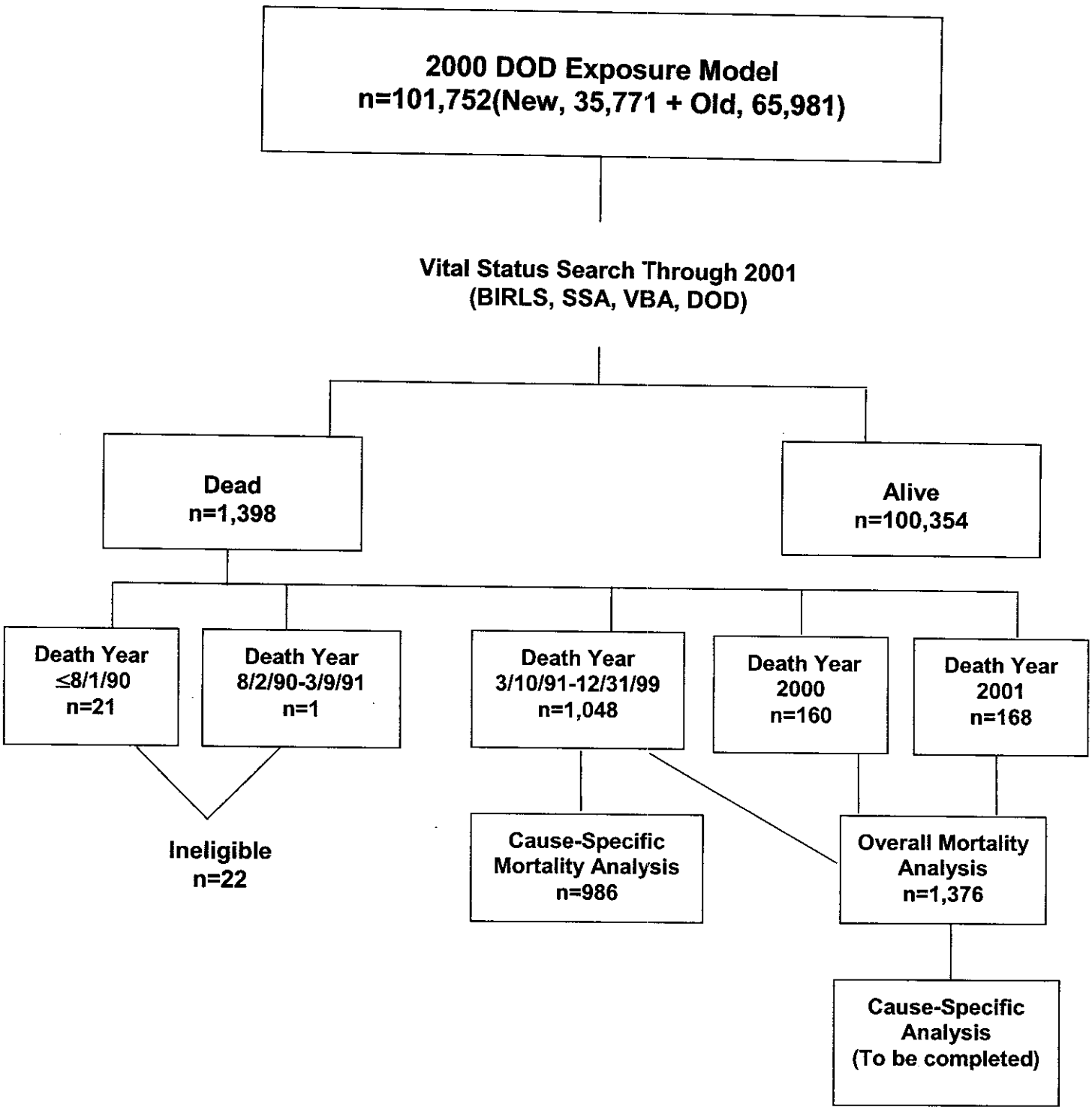

Figure 3: Selection process of eligible veterans for the 2000 DOD exposure model

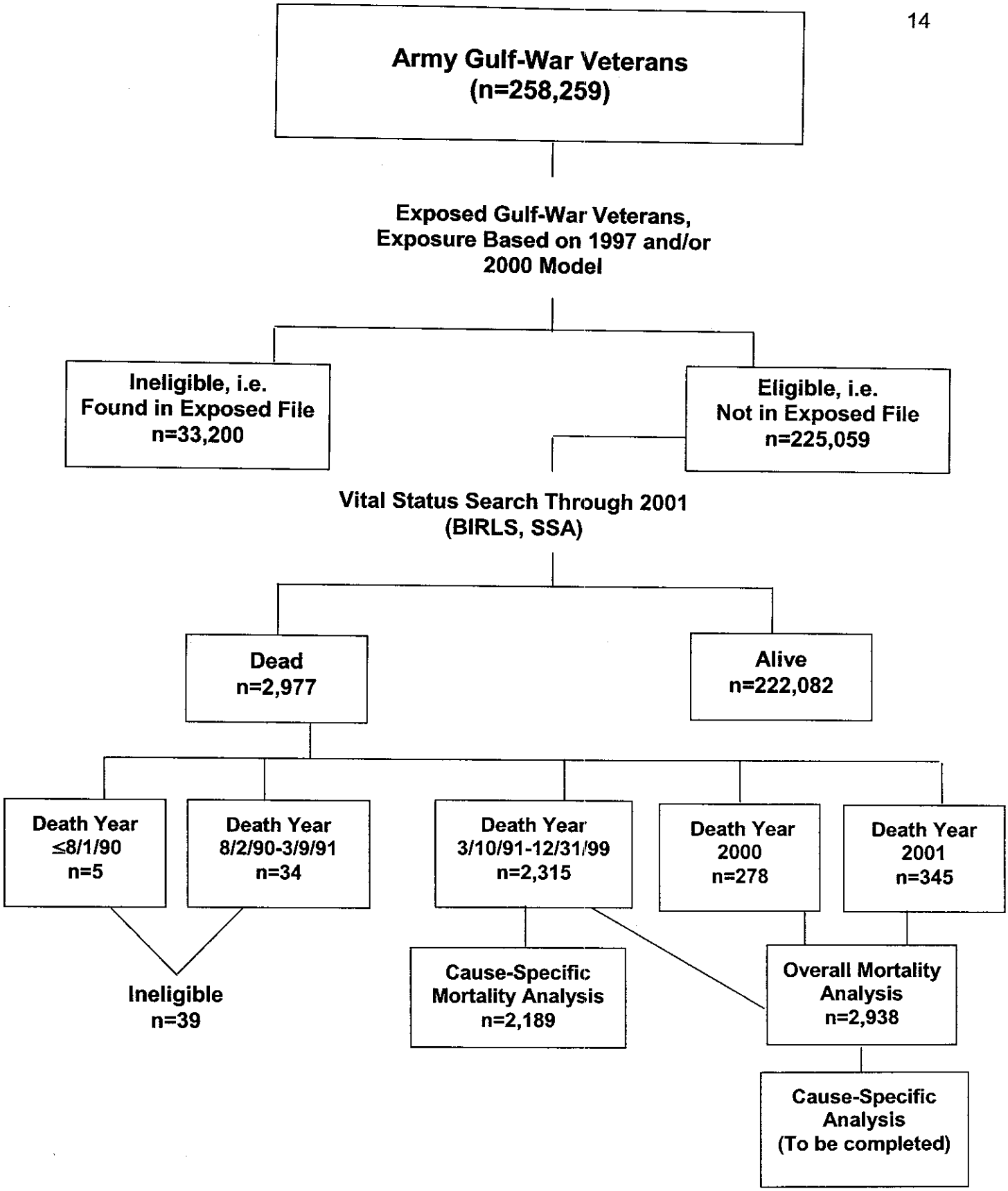

Figure 4: Selection process of eligible veterans for the controls, i.e. unexposed

Table 1. Demographic and military characteristic of Gulf War veterans who were potentially exposed to nerve agents by DoD model year

Characteristic	Exposure Group		
	1997 Model (n=98,539) %	2000 Model (n=101,730) %	Controls (n=225,020) %
Race			
White	62.2	63.0	63.1
Non-White	37.8	37.0	36.9
Sex			
Male	91.6	89.4	90.1
Female	8.4	10.6	9.9
Year of Birth			
≤ 1961	33.5	36.8	35.2
1962-1967	33.1	32.4	32.6
≥ 1968	33.4	30.8	32.2
Rank			
Enlisted	88.9	88.3	89.3
Officer/Warrant Officer	11.1	11.7	10.7
Service Branch			
Army	100	98.8	100
Air Force	—	1.2	—
Type of Unit			
Active	83.4	74.2	75.3
Reserve	9.2	14.1	13.8
National Guard	7.4	11.7	10.9

Table 2. Demographic and military characteristic of Gulf War veterans who were potentially exposed to nerve agents by their exposure group status

Characteristic	Exposure Group*		
	Old (n=65,963) %	New (n=35,767) %	Deleted (n=32,576) %
Race			
White	62.2	64.5	62.1
Non-White	37.8	35.5	37.9
Sex			
Male	90.5	87.5	93.8
Female	9.5	12.5	6.2
Year of Birth			
≤ 1961	34.6	40.9	31.4
1962-1967	33.0	31.2	33.2
≥ 1968	32.4	27.9	35.4
Rank			
Enlisted person	88.5	87.8	89.5
Officer/Warrant Officer	11.4	12.1	10.4
Service Branch			
Army	100	96.6	100
Air Force		3.4	
Type of Unit			
Active	79.4	64.7	91.5
Reserve	11.4	18.9	4.7
National Guard	9.2	16.4	3.8

*Old: Gulf War veterans who were found on both 1997 and 2000 DoD model
New: Gulf War veterans who were only listed on the 2000 DoD model
Deleted: Gulf War veterans who were only listed on the 1997 DoD model

Table 3. Overall deaths, mortality rates, and mortality rate ratios among U.S. Gulf War veterans potentially exposed to nerve agents as compared with Gulf War veteran controls, follow-up through December 2001

Exposure Group (Number in Group)	Number of Deaths*	Mortality Rate†	Mortality Rate Ratios		
			Crude	Adjusted	(95% CI)‡
Gulf Veteran Controls (n=225,020)	2938	12.15	—	—	
1997 DOD Model (n=98,539)	1335	12.61	1.04	1.06	(1.00-1.14)
2000 DOD Model (n=101,730)	1376	12.59	1.04	1.02	(0.96-1.09)
Only in 1997 Model, "D" (n=32,576)	448	12.80	1.05	1.12	(1.02-1.24)
Only in 2000 Model, "N" (n=35,767)	489	12.73	1.05	0.98	(0.89-1.08)
Both in 97 and 2000 Model, "O" (n=65,963)	887	12.52	1.03	1.04	(0.96-1.12)

* The number of deaths from the entry to study (March 10, 1991) through December 31, 2001.

† Mortality rate per 10,000 person-years.

‡ Adjusted mortality rate ratios (and 95% confidence intervals) were derived from the Cox proportional-hazards model after adjustment for age, gender, race and unit component.

Table 4. Estimates of Cox regression parameters for overall mortality risk* among Gulf War veterans who were potentially exposed to nerve agents

Covariates	1997 Model			2000 Model		
	Coefficient	Adjusted Rate Ratio	(95%CI)	Coefficient	Adjusted Rate Ratio	(95%CI)
Khamisiyah Exposure (Y/N)	0.0618	1.06	(1.0 - 1.14)	0.0180	1.02	(0.96-1.09)
Age (in year)	0.0412	1.04	(1.04-1.05)	0.0411	1.04	(1.03-1.05)
Sex (M/F)	0.5362	1.71	(1.50-1.95)	0.5465	1.73	(1.52-1.96)
Race (White/others)	-0.0897	0.91	(0.86-0.97)	-0.099	0.91	(0.85-0.96)
Unit (Reserve and NG/Active)	0.1744	1.19	(1.11-1.28)	0.1767	1.19	(1.12-1.28)

* Includes all deaths through December 2001.

Figure 5. Overall mortality rates among U.S. Gulf War veterans potentially exposed to nerve agents, follow-up through December 2001

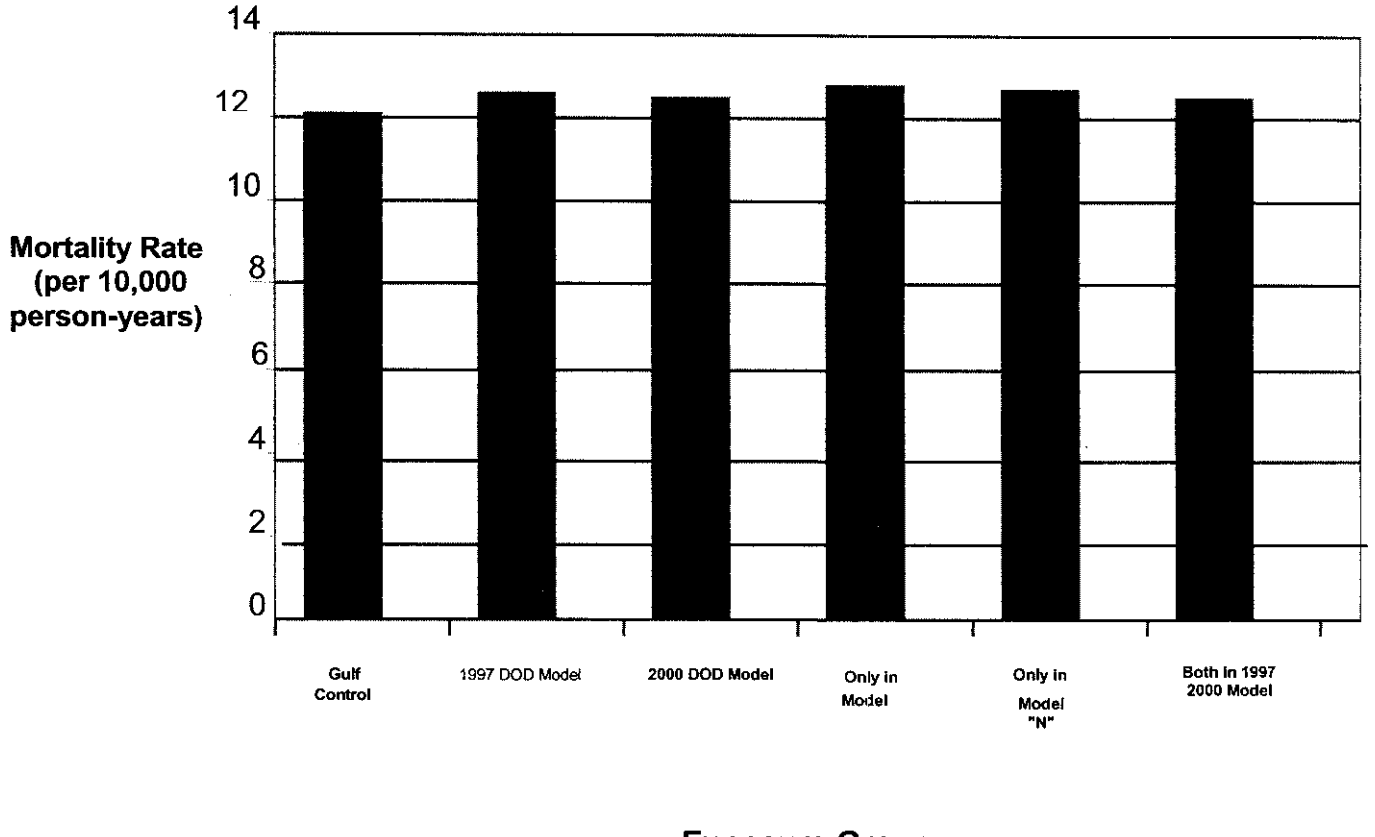

Table 5. Cause-specific mortality rate‡ among U.S. Gulf War veterans who were potentially exposed to nerve agents, follow-up through December 1999.

Exposure Group (person years of follow-up)†	Underlying Cause of Death (ICD-(Codes)*											
	All Natural Causes (001-799)		All Cancer (140-209)		All Circulatory (390-459)		Respiratory (460-519)		Motor Vehicle Accidents (E810-825)		Suicide (E950-959)	
	No	Rate	No	Rate	No	Rate	No	Rate	No	Rate	No	Rate
Gulf Veteran Controls (1,973,049)	896	4.54	341	1.73	325	1.65	38	0.19	499	2.53	332	1.68
1997 DOD Model (863,941)	366	4.24	131	1.52	130	1.51	10	0.12	223	2.58	160	1.85
2000 DOD Model (891,897)	408	4.57	155	1.74	140	1.57	15	0.17	226	2.53	150	1.68
Only in 1997 Model, "D" (285,583)	129	4.52	44	1.54	43	1.51	2	0.07	66	2.31	62	2.17**
Only in 2000 Model, "N" (313,539)	171	5.45**	68	2.17**	53	1.69	7	0.22	69	2.20	52	1.65
Both in 97 and 2000 Model, "O" (578,358)	237	4.09	87	1.50	87	1.50	8	0.14	157	2.71	98	1.69

* Causes of death were unknown for 5.4% of controls, 4.9% of 1997 model, 5.9% of 2000 model, 3.5% of "deleted", 6.3% of "new", and 5.6% of "old" exposure group. IDC-9, International Classification of Diseases, Ninth Revision

† Person years at risk were calculated from the date of entry to study (March 10, 1991) through December 31, 1999.

‡ Mortality rate per 10,000 person-years.

** These rates were further analyzed in comparison to rates for the Gulf War veteran controls by Cox proportional hazards model. (see Table 6)

Table 6. Adjusted mortality rate ratios for selected cause of death

Cause of Death (ICD-9)*	Exposure Group	Mortality Rate Ratios	
		Crude	Adjusted (95% CI)‡
Natural Causes (001-799)	Only in 2000 model "N"ew	1.20	0.99 (0.84-1.17)
All Cancer (140-209)	Only in 2000 model "N"ew	1.25	0.97 (0.74-1.26)
Suicide (E950-959)	Only in 1997 "D"eleted	1.29	1.25 (0.95-1.64)

‡ Adjusted mortality rate ratios (and 95% confidence intervals) were derived from the Cox proportional hazards model after adjustment for age, gender, race and unit component.

* ICD-9, International Classification of Diseases, Ninth Revision

Table 7. Overall and cause-specific standardized mortality ratios (and 95% confidence intervals) for the Gulf War veterans who were potentially exposed to nerve agents, deaths through 1999 as compared with the U. S. population†

Cause of Death (ICD-9)*	Exposure Group		
	Controls	1997 Model	2000 Model
All Causes	0.40(0.38-0.41)	0.40(0.37-0.42)	0.39(0.36-0.41)
Infectious and Parasite (001-139)	0.05(0.04-0.07)	0.05(0.03-0.08)	0.06(0.04-0.08)
All Cancers (140-209)	0.49(0.44-0.55)	0.46(0.39-0.55)	0.46(0.39-0.54)
All Circulatory (390-459)	0.35(0.31-0.39)	0.33(0.28-0.40)	0.31(0.26-0.36)
All Respiratory (460-519)	0.23(0.16-0.32)	0.14(0.07-0.26)	0.19(0.11-0.31)
All Digestive (520-579)	0.12(0.08-0.18)	0.22(0.14-0.34)	0.16(0.10-0.26)
All External Causes (E800-E999)	0.60(0.57-0.63)	0.61(0.57-0.67)	0.60(0.55-0.65)
Motor Vehicle Accidents (E810-825)	0.90(0.82-0.98)	0.90(0.79-1.03)	0.92(0.80-1.04)
Suicide (E950-959)	0.79(0.71-0.88)	0.86(0.73-1.00)	0.80(0.67-0.94)

* IDC-9, International Classification of Diseases, Ninth Revision

† Standardized mortality ratios were calculated by dividing the number of observed deaths by the number of expected deaths in the U.S. population for each cause shown, after standardization for age, sex, race, and calendar year of death.

Table 8. Overall and cause-specific standardized mortality ratios (and 95% confidence intervals) for the Gulf War veterans who were potentially exposed to nerve agents, deaths through 1999 as compared with the U. S. population†

Cause of Death (ICD-9)*	Exposure Group		
	Only in 1997, "D"	Only in 2000, "N"	Both in 97 and 2000, "O"
All Causes	0.42(0.38-0.47)	0.39(0.35-0.43)	0.39(0.36-0.42)
Infectious and Parasite (001-139)	0.05(0.02-0.10)	0.06(0.03-0.11)	0.05(0.03-0.09)
All Cancers (140-209)	0.54(0.39-0.73)	0.51(0.39-0.64)	0.43(0.35-0.53)
All Circulatory (390-459)	0.38(0.27-0.51)	0.30(0.22-0.39)	0.32(0.25-0.39)
All Respiratory (460-519)	0.09(0.01-0.34)	0.23(0.09-0.48)	0.16(0.07-0.32)
All Digestive (520-579)	0.43(0.23-0.73)	0.22(0.10-0.41)	0.13(0.06-0.25)
All External Causes (E800-E999)	0.61(0.53-0.70)	0.56(0.48-0.65)	0.62(0.56-0.68)
Motor Vehicle Accidents (E810-825)	0.79(0.61-1.00)	0.82(0.64-1.04)	0.96(0.82-1.13)
Suicide (E950-959)	0.99(0.76-1.26)	0.80(0.60-1.05)	0.80(0.65-0.97)

* IDC-9, International Classification of Diseases, Ninth Revision

† Standardized mortality ratios were calculated by dividing the number of observed deaths by the number of expected deaths in the U.S. population for each cause shown, after standardization for age, sex, race, and calendar year of death.

Figure 6. Standardized Mortality Ratio for Gulf War veterans who were potentially exposed to nerve agents, Death through 1999 as compared to the U.S. Population

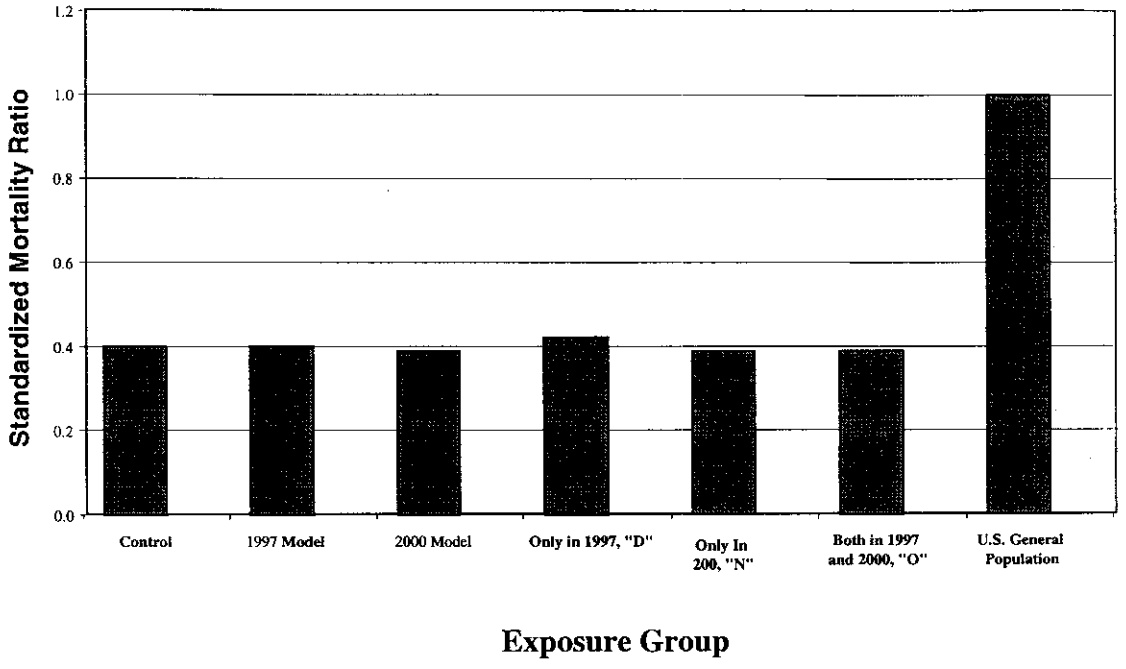

Table 9. Number of Gulf War veterans and deaths identified by VBA, DOD and the Environmental Epidemiology Service

	VBA		DOD/EES		
Exposure Group	Veterans	Deaths	Veterans	Deaths	(VBA Deaths) - (DOD/EES Deaths)
Deleted (Only in 1997 model)	34,418	1011	32,627	448	563
New (Only in 2000 model))	34,638	105	35,771	489	- 384
Old (Both in 97/2000 model)	65,407	221	65,981	887	- 666
1997	99,235	1232	98,608	1335	- 103
2000	100,045	326	101,752	1376	-1050
Overall	134,463	1337	134,379	1824	- 487

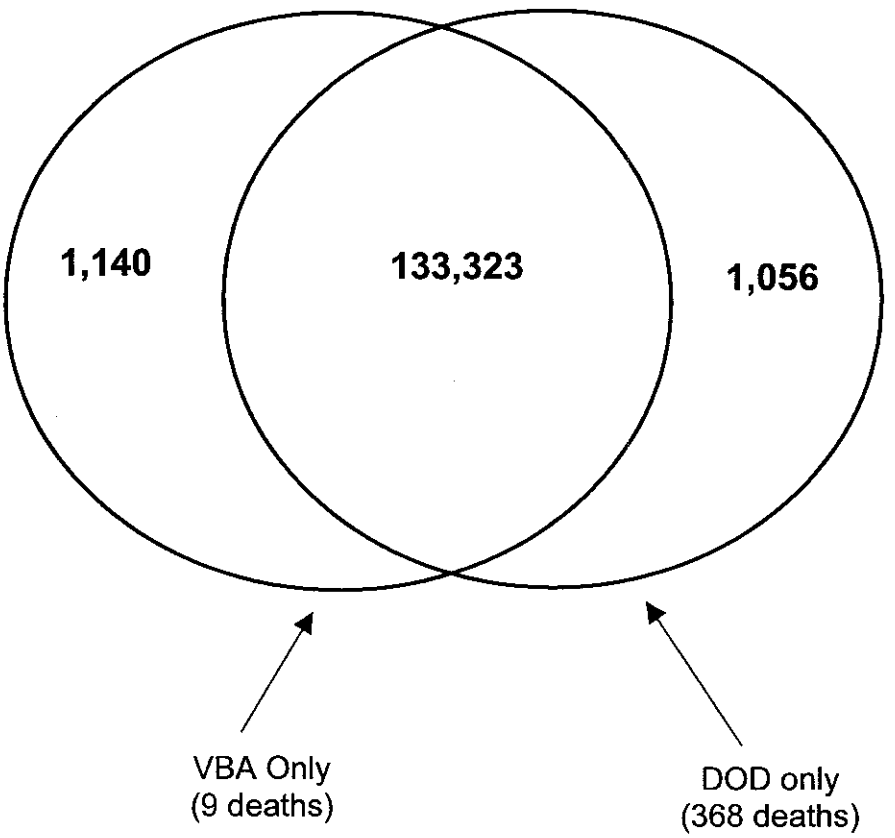

Figure 7: Number of Gulf War veterans in VBA file and DOD file

Table 10. Exposure group classification by DOD or VBA

DOD Exposure Group	VBA Exposure Groups			
	Deleted	New	Old	Total
Deleted	32623	0	0	32623
New	0	34638	82	34720
Old	661*	0	65319	65980
Total	33284	34638	65401	133323

* Of these veterans, 650 were found dead as of December 31, 2001.

Table 11. VBA reported deaths by year of death and exposure group status

Year of Death	New (N=34,638)		Old (n=65,407)		Deleted (n=34,418)		Overall (n=134,463)	
	No Deaths	Rate	No Deaths	Rate	No Deaths	Rate	No Deaths	Rate
≤ 1991	2	0.58	4	0.61	112	32.5	118	8.8
1992	2	0.58	6	0.92	95	27.6	103	7.7
1993	2	0.58	2	0.31	92	26.7	96	7.1
1994	3	0.87	7	1.07	105	30.5	115	8.6
1995	2	0.58	3	0.46	106	30.8	111	8.3
1996	0	0.00	2	0.31	100	29.1	102	7.6
1997	3	0.87	5	0.76	98	28.5	106	7.9
1998	8	2.31	6	0.92	113	32.8	127	9.4
1999	2	0.58	3	0.46	102	29.6	107	8.0
2000	43	12.41	90	13.76	42	12.2	175	13.0
2001	38	10.97	93	14.22	46	13.3	177	13.2
Total	105	3.03	221	3.37	1011	29.37	1337	9.94

Figure 8. VBA reported death rates by year of death and exposure group status